



2015 Minerals Yearbook

KYANITE AND RELATED MINERALS [ADVANCE RELEASE]

KYANITE AND RELATED MINERALS

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In 2015, the United States continued to be the world's leading producer of kyanite and mullite (calcined kyanite), with an estimated combined production of 108,000 metric tons (t) (Virginia Department of Mines, Minerals and Energy, 2016a; tables 1, 7). World production of kyanite and related minerals—andalusite and sillimanite—was estimated to be 408,000 t (tables 1, 7). Domestic synthetic mullite (calcined aluminous and siliceous minerals and clays) production data were withheld to avoid disclosing company proprietary data. In the United States, one company produced kyanite and calcined kyanite, two companies produced synthetic mullite, and one company produced andalusite as part of a mineral mixture. No U.S. production of sillimanite was reported. Refractory products continued to be the foremost end use for kyanite and related minerals, predominantly in ironmaking and steelmaking, and the remainder was used in the manufacture of chemicals, glass, nonferrous metals, and other materials.

This report includes information on the minerals andalusite, kyanite, and sillimanite, all with a formula of Al_2SiO_5 , and on mullite (calcined kyanite) and synthetic mullite with the chemical formula $Al_6Si_2O_{13}$. Andalusite, kyanite, and sillimanite are the primary minerals that are known as kyanite group minerals, especially in the United States where kyanite is prevalent, but they are also known collectively as the sillimanite minerals, particularly in India where sillimanite is the most common of the group. For most end uses of these aluminosilicate minerals, mullite is the preferred mineral because of its superior refractory (heat-resistant) properties (it is stable to 1,800 °C) and high strength, but it is rarely found in nature in minable quantities. In the United States, the term mullite generally refers to mullite that is produced by calcining kyanite (to a temperature of 1,450 °C or more), whereas synthetic or sintered mullite typically refers to mullite made by calcining certain mixtures of alumina- and silica-containing minerals and materials, typically bauxite, bauxitic kaolin, and kaolin, at similarly high temperatures.

Production

In 2015, the production of kyanite and mullite in the United States remained at an estimated 108,000 t (Virginia Department of Mines, Minerals and Energy, 2016a; tables 1, 7). The value of kyanite and mullite produced in the United States in 2015 was estimated to have increased to about \$37 million (table 1).

A U.S. Geological Survey (USGS) voluntary survey was sent to the sole U.S. producer of kyanite and kyanite-derived mullite in 2015, Kyanite Mining Corp. (KMC), which responded to the survey, but these data are withheld to avoid disclosing company proprietary data. KMC has mined kyanite deposits in central Virginia since 1945. The company operated the East Ridge and Willis Mountain open pit mines in Buckingham County

and beneficiated the ore into a marketable kyanite concentrate product. An estimated 15% to 20% of this kyanite concentrate was further processed and converted by calcination into mullite; more than 90% of this conversion was at the company's Willis Mountain plant and the remainder was at the Gieseke Plant (East Ridge), just south of Dillwyn, VA. KMC's concentrate graded 92% to 96% kyanite containing between 55% and 60% alumina (Al_2O_3); the derived mullite product contained about 80% mullite (Kyanite Mining Corp., 2006; Virginia Department of Mines, Minerals and Energy, 2016b).

C-E Minerals, Inc. (a subsidiary of Imerys Refractory Minerals SA) produced synthetic mullite from calcined bauxite, bauxitic kaolin, and kaolin clays near Americus, GA. C-E Minerals produced various products that contained 65%, 77%, and 87% mullite that typically contained 47%, 59%, and 69% Al_2O_3 , respectively (C-E Minerals, Inc., 2015). Mineral Manufacturing Corp. produced synthetic mullite in Eufaula, AL, from materials mined from one site in Alabama and one in Georgia.

Piedmont Minerals Co., Inc. mined a deposit of andalusite combined with pyrophyllite and sericite at Hillsborough, NC. The company sold products containing blends of the three minerals to producers of refractories, especially for the production of firebrick.

Consumption

The dominant end use for kyanite group minerals was refractories and refractory products, accounting for as much as 90% of consumption. An estimated 65% of these minerals used in refractories were for the production of iron and steel, and the remainder was for the manufacture of chemicals, glass, nonferrous metals, and other materials. When calcined to mullite, kyanite increases in volume, depending upon particle size, typically by 2% for very fine particles (325 mesh) to as much as 25% for coarser particle fractions (35 mesh), and thus can be used as a raw concentrate in a refractory mixture to offset the shrinkage on firing of other components, especially types of clay. Andalusite and sillimanite expand irreversibly by about 6% and 2% to 4%, respectively, when calcined and individually can be used directly in refractories in their raw state (Lassetter, 2015). In refractory applications where the volume increase of kyanite is not required, kyanite concentrate is first calcined to mullite and added to refractory mixes. Mullite is resistant to abrasion and penetration by deleterious dusts, gases, and slags, and has beneficial creep resistance, which limits physical deformation under load at high temperatures (Roskill Information Services Ltd., 1990, p. 56, 63).

Examples of refractories that contain andalusite, kyanite, or mullite include insulating brick, firebrick, kiln furniture, refractory shapes, and monolithic refractories (made of a

single piece or as a continuous structure) including castables (refractory concrete), gunning mixes, mortars, plastics, and ramming mixes. Monolithic refractories are supplied in unfired and unshaped form, in contrast to prefired and preshaped brick products, and may be gunned, hand packed, molded, poured, pumped, rammed, or vibrated into place (Moore, 2004).

Crude steel output in the United States decreased by 10.5% in 2015 compared with that of 2014; world crude steel output decreased by about 2.8% in 2015. Decreases in crude steel output also took place in most other countries, including China; India and Spain were the main exceptions, up by 2.6% and 4.4%, respectively. Decreased steel output can have a negative impact on the demand for raw materials used in refractories, such as the kyanite group minerals. The leading steel-producing countries, which also would be leading consumers of refractory products, included China, which alone accounted for nearly 50% of the world's steel production in 2015; Japan, 6.5%; India, 5.5%; the United States, 4.9%; Russia, 4.4%; the Republic of Korea, 4.3%; and Germany, 2.6%. These countries accounted for nearly 78% of world steel production in 2015 (World Steel Association, 2016a).

Other end uses of kyanite group minerals included high-friction products such as motor vehicle brake shoes and pads; abrasive products such as grinding and cutting wheels; ceramic products such as electrical insulating porcelains, sanitaryware, and whiteware; foundry products and precision casting molds; and other products (Kyanite Mining Corp., 2006).

Prices

Based on data received through the USGS survey of domestic kyanite production, the unit value of raw kyanite concentrate and calcined kyanite (mullite) was largely dependent on grade and sizing. The average unit value increased slightly in 2015. Prices for kyanite and andalusite serve only as a general guide; a comparison of yearend prices for 2013–15 is shown in table 2.

Foreign Trade

Exports of kyanite (excluding mullite) remained nearly the same as those of 2014 with a slight increase in value to \$13.9 million in 2015 and were shipped to 39 countries (table 3). Germany, China, the Netherlands, Mexico, Japan, Belgium, Italy, the Republic of Korea, Canada, and the United Kingdom (in descending order by tonnage) combined received 84% of U.S. kyanite exports. Exports of mullite (calcined kyanite or synthetic) increased by about 21% to 26,900 t valued at about \$11 million and were shipped to 18 countries (table 4). About 91% of U.S. mullite exports went to Mexico, Canada, Germany, and the United Kingdom, in descending order of quantity (table 4).

Imports of kyanite group minerals (mostly andalusite) nearly tripled in 2015 to 11,500 t valued at \$3.68 million (tables 1, 5). More than 66% of these imports were from South Africa and 31% from Peru (table 5). Imports of mullite (calcined kyanite or synthetic, unspecified) decreased by 29% to 5,190 t, with a 4% decrease in value to \$5.7 million (table 6). The small decrease in the value of mullite imports relative to the significantly larger decrease in the quantity imported was largely

attributed to a substantial decrease in lower valued imports from China. Overall, the leading sources of mullite imports were Canada with 51%; Germany, 22%; Brazil, 12%; and Hungary, 10% (table 6).

World Review

South Africa continued to be the leading producer of andalusite, and India was the leading producer of sillimanite (table 7). Countries thought to be producers of synthetic mullite included Brazil, Canada, China, Germany, Guyana, Hungary, Japan, Russia, and the United States.

The irregular availability of inexpensive refractory-grade bauxite from China served to increase the demand for refractories from alternate raw materials such as andalusite. The leading andalusite producers, China, Peru, and South Africa, continued to expand operations. Production of low-iron, refractory-grade bauxite was reported from mines in Brazil, Guyana, and Russia, potentially representing competition for the kyanite group minerals, especially andalusite (Saxby, 2013).

China.—Although China was thought to produce kyanite group minerals, detailed production data have been unavailable since 2003. A production capacity of 40,000 metric tons per year (t/yr) was reported for Yilong Andalusite Mineral Co. [a subsidiary of Imerys SA (Paris, France)] in the Xinjiang Uyghur Autonomous Region of northwestern China (Torrison, 2014a; Lismore-Scott, 2015).

France.—Imerys Refractory Minerals, which produces andalusite under the trade name Kerphalite™, mined andalusite from three mine pits at its Glomel Mine in Brittany, France (Imerys Refractory Minerals SA, 2015; Lismore-Scott, 2015).

India.—India was by far the world's leading producer of sillimanite. Little is known about sillimanite production elsewhere, although India annually imports very small quantities from France, Japan, and Nepal. About three-quarters of India's production of sillimanite was reported by the private sector, and the remainder of production was reported by the public sector. Most of the production was from two States, Andhra Pradesh and Odisha, accounting for 65% and 20% of the country's production, respectively. About 46% of production was exported with 87% of exports going to China. About 1,900 t of kyanite was produced in the State of Maharashtra. India has relied on imports of andalusite since 1988 when the mining of andalusite last took place (Indian Bureau of Mines, 2014, p. 64–65, 114–115).

Peru.—Andalucita S.A., which produced a large majority of Peru's andalusite, continued development and production from its mine in unconsolidated sand and gravels of the Tablazo Mancora flood plain in northwestern Peru, 20 kilometers (km) from the deep seaport of Paita. Upgrades to its processing plant in 2013 increased the operation's production capacity to 37,000 t/yr from its 25,000-t/yr capacity in 2012. The planned addition of more screens would increase the plant's capacity to between 48,000 and 60,000 t/yr (Carmichael and Lismore-Scott, 2013; Torrison, 2014a). Its primary andalusite product graded 59% to 60% Al₂O₃, with a maximum of 0.85% iron oxide (Lismore-Scott, 2014). In 2015, 31,000 t of andalusite was exported from Peru mostly to customers in Europe,

North America, and South America (United Nations Statistics Division, undated).

After being hampered by a difficult investment climate during the past several years, Latin Resources Ltd. (Perth, Western Australia, Australia) succeeded in renegotiating the purchase price of its Guadalupito andalusite and heavy-mineral-sands project in Peru to slightly less than \$8 million from the original \$13 million. The deal included issuing 2 million ordinary shares per year to the sellers for 4 years. Under the terms of the deal, cash obligations to the seller were eliminated until the issuance of a favorable definitive feasibility study (DFS) (due by mid-2019), thereby freeing up funding to complete the study and make the project more attractive to the needed joint-venture investment partner (Syrett, 2015).

The Guadalupito project is on the eastern inland portion of the coastal plain of Peru about 25 km from the port city of Chimbote. The project's Los Conchaes resource, which covers 1,350 hectares, was estimated to contain 1.1 billion tons of heavy-mineral sands (heavy-mineral content of 8% to 10%) containing mostly andalusite (21% to 24%) and magnetite (22% to 25%) and lesser quantities of apatite, garnet, ilmenite, monazite, rutile, and zircon. The andalusite is found mostly as individual particles in the deposit, more than 90% of which is below the water table making it amenable to dredge mining. Based on testing in 2014, the deposit was expected to produce an andalusite product grade of greater than 60% Al_2O_3 with less than 0.2% iron oxide. Latin Resources planned to market its production to the refractory and technical ceramics industries. Bulk processing of andalusite samples by gravity concentration, using classifiers and magnetic separation to remove magnetic minerals such as magnetite, was planned in the DFS and early stages of the project. The company planned to use a conventional dredge mining operation and to begin production at an initial rate of 15 million metric tons per year at a minimum mine life of 15 years (Torrison, 2014a; Latin Resources Ltd., 2015a, 2015b, p. 16–19; Syrett, 2015).

South Africa.—South Africa's Competition Commission blocked the proposed takeover by Imerys of Andalusite Resources (Pty.) Ltd. The Commission determined that the merger would create an andalusite supply monopoly within South Africa, making the mineral more expensive to local consumers by removing competition in the fine-grade and medium-grade andalusite markets with no alternative domestic supplier in South Africa (Greve, 2015; Lismore-Scott, 2015). In September, Imerys and Andalusite Resources jointly began an appeal of the decision. But in October, owing to delays by the companies to provide information to the Commission supporting their case, South Africa's Competition Tribunal suspended the case until February 2016. Local steel producers and other andalusite consumers in South Africa were opposed to the merger (Gyekye, 2015; Syrett and McCormick, 2016).

Andalusite Resources (Pty.) Ltd. mined andalusite at its Maroelasfontein Mine in Thabazimbi, Limpopo Province. Development at the mine, which had a production capacity of 70,000 t/yr in 2014, continued with work aimed at increasing capacity to 90,000 t/yr by yearend 2015 and to 120,000 t/yr during the next several years. More than 25% of the company's annual production went to domestic markets, between 30% and

40% to Europe, and the remainder to Japan (Carmichael and Lismore-Scott, 2013; Torrison, 2014a).

Denain-Anzin Mineraux Refractaire Ceramique (Damrec) (a subsidiary of Imerys SA) produced about 70% of the andalusite in South Africa at four mines, which had a combined capacity of 195,000 t/yr of andalusite. Damrec planned to increase output to 250,000 t/yr over the next several years. Rhino Minerals (Pty.) Ltd. operated three of Damrec's mines in South Africa: the Annesley, Havercroft, and Rhino Mines in Limpopo Province. Samrec (Pty.) Ltd. was the operator of the Krugerspost Mine near Lydenburg, Mpumalanga Province, which had been idle since 2013. Imerys temporarily mothballed the Krugerspost Mine to concentrate on production from the company's other mines and plants in order to increase the output and quality of its purusite andalusite product, expand its mineral reserves, and emphasize coarse-size products (Torrison, 2014b). Damrec's main markets were China, Europe, India, and South Africa (Carmichael and Lismore-Scott, 2013; Torrison, 2014a; Modiselle, 2015, p. 203–208).

Outlook

Natural raw aluminosilicate minerals, such as andalusite and kyanite, have become increasingly sought after as alternative materials to calcined bauxite in certain refractory applications. When compared to raw materials with higher alumina content, andalusite is expected to be an increasingly attractive alternative especially as the availability of the mineral increases from the expansion of operations in South Africa and anticipated increases in production from Peru (Torrison, 2014a, b). Andalusite is able to be fired at a lower temperature than most alternative materials when used to produce a dense and shrinkage-resistant refractory aggregate, which reduces energy consumption and greenhouse gas emissions (Feytis, 2011). Nevertheless, inexpensive refractory-grade bauxite that becomes available for export from projects under development in Brazil, Guyana, and Russia may become competitive with andalusite and kyanite in some applications, such as steel furnaces and industrial boilers (Saxby, 2013). For durable refractories, technological advances are likely to include increased use of synthetic mullite.

Although the apparent consumption of steel, the leading industrial market for refractories, decreased by 10.6% in 2015 (World Steel Association, 2016b, p. 16), the consumption of steel in the United States is expected to increase by 3.2% in 2016 and 2.7% in 2017 owing to a strong housing sector, continued momentum in the automotive markets, anticipated growth in manufacturing, and an improving job market (World Steel Association, 2016c). The domestic steel industry has been negatively affected by competition from low-priced imports of steel from overseas producers, especially from China, and from the slump in oil prices that slowed drilling activities and thus consumption of steel products in that market. Based on preliminary findings of the U.S. Department of Commerce (DOC), imports of some anticorrosive steel from China may have antidumping duties of up to 236% imposed based on the recent level of subsidies that five Chinese exporters have been receiving. The investigation also involved imports from the Republic of Korea, India, Italy, and Taiwan. Companies from

Italy and India were subsidized as much as 38.4% and 7.7%, respectively. This was the first decision in three sets of trade cases that U.S. steel producers filed in 2015, in which they claimed that output from foreign producers led by China pushed down prices to 9-year lows, contributing to U.S. steel mills idling 31% of capacity. According to the U.S. Census Bureau, imports of the anticorrosive steel from the five target countries rose by 84% in 2014, whereas imports of all steel products increased by 38%. On October 30, the DOC found that imports jumped from four of the five countries at the beginning of the investigation: China, the Republic of Korea, Taiwan, and Italy. Such circumstances might justify the Department sanctioning retroactive duties on those shipments as well. If enacted, resulting tariffs would be expected to help the domestic steel industry better compete with imports and thus continue its need for raw refractory materials (Elmquist, 2015).

World steel consumption is expected to decrease by about 0.8% in 2016 and return to growth of 0.4% in 2017, following a larger-than-expected contraction of 3% in 2015. Because of continuing efforts by the Government of China to manage domestic growth, especially in its real estate sector, and to rebalance its economy, steel consumption in China is expected to continue to contract between 3% and 4% in the next 2 years (World Steel Association, 2016c). The Asia-Pacific region remains the largest market for refractories, and although growth has slowed slightly in China's economy, China is anticipated to continue to be the single leading market and represent the majority of global consumption. Although the deceleration in apparent steel consumption is expected to continue temporarily, China's more than 2-billion-metric-ton-per-year cement industry continues to require raw materials such as kyanite group minerals for refractory products used in cement plants. Continued growth is expected in China's cement industry.

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GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

- Historical Statistics for Mineral and Material Commodities in the United States. Data Series 140.
- Kyanite and Related Minerals. Ch. in *Mineral Commodity Summaries*, annual.
- Kyanite and Related Minerals. Ch. in *United States Mineral Resources*, Professional Paper 820, 1973.

Other

- Kyanite and Related Minerals. Ch. in *Mineral Facts and Problems*, U.S. Bureau of Mines Bulletin 675, 1985.

TABLE 1
SALIENT KYANITE AND RELATED MINERALS STATISTICS¹

		2011	2012	2013	2014	2015
Production						
Kyanite:						
Quantity (includes calcined kyanite) ²	metric tons	98,200	98,500	110,000 ^r	89,000 ^r	108,000
Value ^e	thousands	\$31,000	\$31,000	\$38,000 ^r	\$29,000 ^r	\$37,000
Synthetic mullite:^e						
Quantity	metric tons	W	W	W	W	W
Value	thousands	W	W	W	W	W
Exports of kyanite concentrate:³						
Quantity	metric tons	38,100	36,400	42,400	40,000	39,900
Value ⁴	thousands	\$11,600	\$11,700	\$13,100	\$13,600	\$13,900
Imports for consumption, all kyanite minerals:³						
Quantity	metric tons	5,390	3,260	4,110 ^r	4,020	11,500
Value ⁵	thousands	\$2,230	\$1,610	\$1,610 ^r	\$1,550	\$3,680
Consumption, apparent	metric tons	W	W	W	W	W
World, production ^e	do.	357,000	333,000	370,000 ^r	382,000 ^r	408,000

^eEstimated. ^rRevised. do. Ditto. W Withheld to avoid disclosing company proprietary data.

¹Data are rounded to no more than three significant digits.

²Source: Virginia Department of Mines, Minerals and Energy, 2016a, DMM report TNPR.06—Comparison of annually reported tonnage data: Charlottesville, VA, Virginia Department of Mines, Minerals and Energy. (Accessed April 25, 2016, via <http://www.dmme.virginia.gov/DMM/miningdata.shtml>.)

³Source: U.S. Census Bureau.

⁴Free alongside ship (f.a.s.) value.

⁵Customs value.

TABLE 2
PRICES OF KYANITE AND RELATED MINERALS

Material		Price, December 31, 2013	Price, December 31, 2014	Price, December 31, 2015
Andalusite, South Africa, 57% to 58% alumina, 2,000-metric-ton bulk lots	euros per metric ton	235–280	248–306	240–290
Andalusite, free on board, South Africa, 55% to 59% alumina, 2,000-metric-ton bulk lots, European port	do.	350–425	375–449	355–425
Kyanite, United States, ex-works, raw, 54% to 60% alumina	dollars per metric ton	247–353	225–290	225–320
Kyanite, United States, ex-works, calcined (mullite), 54% to 60% alumina, 22-ton lots	do.	411–484	340–399	375–440
do. Ditto.				

Source: Industrial Minerals magazine (London) via <http://www.indmin.com>.

TABLE 3
U.S. EXPORTS OF KYANITE, BY COUNTRY^{1,2}

Country	2014		2015	
	Quantity (metric tons)	Value ³ (thousands)	Quantity (metric tons)	Value ³ (thousands)
Argentina	160	\$44	160	\$47
Australia	483	144	520	173
Bangladesh	20	8	20	9
Belgium	2,420	796	2,700	917
Brazil	180	54	120	37
Canada	2,060	782	1,690	644
Chile	100	25	88	26
China	9,600	3,080	6,540	2,150
Colombia	100	26	62	17
Denmark	109	41	100	34
Dominican Republic	--	--	3	3
Egypt	220	57	200	59
Germany	7,280	2,520	6,850	2,420
Greece	22	7	20	7
Guatemala	42	10	42	11
Hungary	--	--	260	92
India	347	119	561	187
Indonesia	361	91	300	77
Ireland	5	3	3	4
Italy	1,380	451	1,810	615
Japan	3,040	1,220	3,300	1,350
Korea, Republic of	1,920	603	1,800	582
Malaysia	300	77	340	98
Mexico	3,190	1,150	3,640	1,350
Netherlands	922	324	3,920	1,370
Peru	--	--	20	6
Philippines	20	5	40	12
Russia	--	--	60	16
Slovenia	--	--	300	74
South Africa	22	5	29	9
Spain	625	196	982	272
Sweden	852	272	919	313
Taiwan	625	152	440	116
Thailand	300	80	220	62
Turkey	527	152	479	155
Ukraine	22	6	--	--
United Arab Emirates	62	18	60	18
United Kingdom	2,680	1,060	1,310	554
Venezuela	--	--	4	3
Vietnam	--	--	20	6
Total	40,000	13,600	39,900	13,900

-- Zero.

¹Harmonized Tariff Schedule of the United States code 2508.50.0000 for kyanite concentrate.

²Data are rounded to no more than three significant digits; may not add to totals shown.

³Free alongside ship (f.a.s.) value.

Source: U.S. Census Bureau.

TABLE 4
U.S. EXPORTS OF MULLITE, BY COUNTRY^{1,2}

Country	2014		2015	
	Quantity (metric tons)	Value ³ (thousands)	Quantity (metric tons)	Value ³ (thousands)
Austria	--	--	7	\$10
Bangladesh	44	\$17	60	28
Belgium	251	123	308	156
Brazil	3	11	16	12
Bulgaria	20	8	--	--
Canada	10,500	3,290	9,840	2,950
China	968	464	408	209
France	3	7	33	35
Germany	1,800	944	2,590	2,100
Hungary	--	--	400	206
India	20	9	20	13
Italy	324	159	400	182
Japan	1	6	5	4
Mexico	6,260	2,630	9,910	3,890
Netherlands	804	373	567	257
Taiwan	207	93	118	52
Thailand	--	--	6	3
United Kingdom	1,040	546	2,230	927
Uruguay	6	3	16	7
Total	22,300	8,680	26,900	11,000

-- Zero.

¹Harmonized Tariff Schedule of the United States code 2508.60.0000 for mullite (calcined kyanite or synthetic).

²Data are rounded to no more than three significant digits; may not add to totals shown.

³Free alongside ship (f.a.s.) value.

Source: U.S. Census Bureau.

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF ANDALUSITE,
KYANITE, AND SILLIMANITE^{1,2,3}

Country	2014		2015	
	Quantity (metric tons)	Value ⁴ (thousands)	Quantity (metric tons)	Value ⁴ (thousands)
France	303	\$219	165	\$88
Peru	99	44	3,590	1,030
South Africa	3,500	1,230	7,650	2,510
United Kingdom	55	45	38	28
Other	68	10	105	16
Total	4,020	1,550	11,500	3,680

¹Most material is thought to be andalusite.

²Harmonized Tariff Schedule of the United States code 2508.50.0000 for kyanite concentrate.

³Data are rounded to no more than three significant digits; may not add to totals shown.

⁴Customs value.

Source: U.S. Census Bureau.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION OF MULLITE^{1,2}

Country	2014		2015	
	Quantity (metric tons)	Value ³ (thousands)	Quantity (metric tons)	Value ³ (thousands)
Brazil	548	\$576	642	\$585
Canada	2,940	2,230	2,650	2,150
China	2,760	1,160	115	112
Germany	768	1,630	1,130	2,130
Hungary	203	254	498	546
Japan	42	118	101	99
Other	11	28	62	116
Total	7,270	6,000	5,190	5,740

¹Harmonized Tariff Schedule of the United States code 2508.60.0000 for mullite; calcined kyanite; or synthetic, unspecified.

²Data are rounded to no more than three significant digits; may not add to totals shown.

³Customs value.

Source: U.S. Census Bureau.

TABLE 7
KYANITE AND RELATED MINERALS: WORLD PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country and commodity ³	2011	2012	2013	2014	2015 ^c
Australia, kyanite ^e	1,000	1,000	1,000	1,000	--
India: ⁴					
Kyanite	4,537	1,816	1,708	2,000	2,000
Sillimanite	56,601	47,604	57,132	60,000	63,000
Total	61,138	49,420	58,840	62,000	65,000
Peru, andalusite ^e	10,000	20,000	20,000	30,000	35,000
South Africa, andalusite	186,242	163,801	180,000	200,000	200,000
United States, kyanite ^{5,6}	98,200	98,500	110,000 ^r	89,000 ^r	108,000
Grand total ^c	357,000	333,000	370,000 ^r	382,000 ^r	408,000

^cEstimated. -- Zero.

¹Grand totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Includes data available through February 12, 2016.

³In addition to the countries listed, France produced andalusite and Brazil and China produced kyanite and related materials. Output is not reported quantitatively and no reliable basis is available for estimation of output levels.

⁴Data are for fiscal year ending March 31 of the following year.

⁵Does not include synthetic mullite.

⁶Source: Virginia Department of Mines, Minerals and Energy, 2016a, DMM report TNPR.06—Comparison of annually reported tonnage data: Charlottesville, VA, Virginia Department of Mines, Minerals and Energy. (Accessed April 25, 2016, via <http://www.dmme.virginia.gov/DMM/miningdata.shtml>).